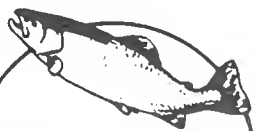# Processing of Digital Data Logger STD Tapes at the Scripps Institution of Oceanography and the Bureau of Commercial Fisheries, La Jolla, California

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Processing of Digital Data Logger STD Tapes at the Scripps Institution of Oceanography and the Bureau of Commercial Fisheries, La Jolla, California

By

JAMES H. JONES

CONTENTS

ABSTRACT

The development of continuous sampling STD (salinity-temperature-depth) sensors as a prime data collection tool for oceanographic cruises has necessitated the development of techniques capable of handling the data with modern digital computing equipment. This paper describes one such technique that was developed for processing STD data collected as part of the EASTROPAC Survey Program. The description assumes that the data has been digitized and recorded on IBM compatible tape in the field. The computer programs needed for processing the basic data tapes are described, and a listing of the program with subroutines is given in the Appendix.

Processing of Digital Data Logger STD Tapes

at the

Scripps Institution of Oceanography

and the

Bureau of Commercial Fisheries,

La Jolla, California

By

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INTRODUCTION

As part of the EASTROPAC Survey Program, computer programs were developed to process STD (salinity-temperature-depth) data from Bisset-Berman model 9006 systems,[2] and record them on incremental IBM compatible DDL's (digital data loggers), also manufactured by the same company. The accuracy and precision of these two instruments are described in the manufacturing brochures and are not discussed here. During the EASTROPAC Program, about 10,000 m. of field tapes were generated which required editing and data processing.

The purpose of this paper is to describe the methods developed for processing the field tapes to a point where the data produced from them may be compared with some independent calibration such as conventional Nansen casts or Niskin samplers, attached to the STD's.

In its present form, the DDL samples each of four channels of information about once every 0.2 second, and writes a seven-channel IBM compatible tape at a bit density of 200 bits per inch. At a drop rate of 60 m. depth per minute, salinity, temperature, depth, and the optional sound velocity channel are sampled five times in each 1-m. interval. Since the

uncertainty of the depth sensor is about 1 m., at this maximum sampling rate, five values of temperature and salinity are available to produce one value per meter. The program described below is based on the premise that the original field tapes are recorded at this maximum rate. Slower sampling rates require slight modification of the low-pass filters used in the program. The fourth and optional channel of sound velocity is not used on any STD systems of the Scripps Institution of Oceanography, or the Bureau of Commercial Fisheries; therefore no description of schemes to process the optional channel is included.

PRELIMINARY PROCESSING

When the field tapes are received at the data-processing center they are first passed through a computer routine which examines

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[1]Work for this manuscript was done while the author was employed by the Bureau of Commercial Fisheries Fishery-Oceanography Center, La Jolla, Calif. 92037.

[2]Use of trade names does not imply endorsement by the Bureau of Commercial Fisheries.

them, file by file, and lists the binary length of the first record as well as the total number of records per file. Any parity errors in the records examined are also listed.

The ideal field tape contains no parity errors. The first record of the first file is an information record and, in the format used by us, is a three-digit number signifying the cast number for that particular cruise. The binary length of this record is always 1. The second file consists of the data recorded by the data logger and may contain any number of records depending, among other things, on the maximum depth attained and the drop rate. A 500-m. cast at a drop rate of 60 m. per minute has about 50 records per file.

In its present form the data logger is designed to produce a binary data record length of 52.[3] Thus, in the ideal field tape the files alternate between an information file containing only one record with a binary length of 1 and a data file with many records, all with a binary length of 52. The preliminary listing of the field tapes provides the programmer with a picture of how far his tapes deviate from the ideal. If the contents of the first record are printed during the preliminary listing, the cast numbers may be identified with individual data files.

The next step in the data processing is to produce, from the field tapes, a high-density tape which is free of parity errors and other anomalies which confuse the tape translation. In the transfer from low- to high-density tape, we have chosen to eliminate all records containing parity errors and records not of binary length 1 or 52. Our experience is that we lose no more than 3 percent of the original data in this way. The high-density tape, free of tape errors, is then considered to be the basic data; the original field tapes are erased, checked and readied for the next cruise.

THE PROGRAM

The program and subroutine functions are outlined in figure 1, and a listing of the program, as run on the CDC 3600 at UCSD (University of California, San Diego), is provided in the Appendix. The main program

RDEDTP (read and edit tape) reads in, from cards, a list of the files to be translated from the basic tape and a list of station numbers that are to be associated with data lists. The file containing the station number is read and translated if it is in the proper format. If it is missing or in an improper format, as determined from the preliminary tape listing, the proper station number is determined from a logbook for the data logger and is read in from a card.

The first subroutine, TRANS, translates, record by record, the digitized frequencies into salinity in parts per thousand, temperature in degrees Celsius, and depth in meters. Maximum and minimum bounds are specified for the depth so that any values outside these limits are rejected.

During the field operations, the sensor package is sometimes temporarily stopped at an intermediate depth to make adjustments to the pens or the winch. The data logger is usually left running on these stops, but the records are of no use in producing a vertical profile; subroutine BASKET is accordingly called to delete the records where the depth has not increased. The final control is a counter which provides for a jump out of TRANS before memory overflows can occur.

A sample output of the record produced by subroutine TRANS is given in figure 2. The fourth column of each set is an absolute counter for the file, which increases only when an acceptable set of salinity, temperature, and depth is translated. When the lower depth bounds are exceeded, the counter is not increased and that set of data is not saved for transmittal to the smoothing subroutine. The 0's printed at the beginning of the file in the first record indicate nonacceptable data, since the depth is less than the minimum of -0.2 m. set in the subroutine. In the first record of this file only 16 sets of salinity, temperature, and depth were acceptable.

Between TRANS and the next subroutine, the maximum and minimum values of salinity,

_____

[3]The magnetic tape record is 416 tape frames long, which is the equivalent of 52 computer records.

COMPUTER PROGRAM LINKAGE
FOR
PROCESSING DIGITAL STD TAPES

Program RDEDTP

Inputs for STD and DDL constants.
Reads files to be processed and station
numbers to be added.

Subroutine TRANS
Translates binary representations of STD
frequencies to engineering units.
Performs minor preliminary editing.

Subroutine BASKET
Compares adjacent records and discards
those showing no depth change.

Subroutine SMOOTH
Applies a double running mean to all
three channels and decimates after
the second.

Subroutine INTERP
Looks at depth, temperature and salinity
on a one meter interval and either averages
or interpolates values of temperature and
salinity for each meter.
Output statements.

Subroutine SALTFX
Applies dT/dt corrections to salinity
values.

Figure 1.–Computer program linkage for processing digital STD tapes.

Figure 2.—Salinity, temperature, and depth values translated by subroutine TRANS. The fourth column is a counter which increases only when a value is acceptable for transmission to subroutine SMOOTH. The 0 counter values at the top of the first page denote inacceptable observations as the depth falls outside the minimum limit. The station was EASTROPAC 75.115, an STD cast to a nominal depth of 150 m.

Salinity	Temperature	Depth	Counter
34.941	21.56	-.5	-0
34.940	21.55	-.6	-0
34.940	21.57	-.5	-0
34.939	21.57	-.3	-0
34.938	21.57	-.5	-0
34.949	21.56	-.5	-0
34.953	21.56	-.5	-0
34.947	21.56	-.5	-0
34.938	21.57	-.6	-0
34.934	21.60	-.5	-0
34.929	21.60	-.5	-0
34.933	21.59	-.5	-0
34.942	21.60	-.3	-0
34.944	21.63	-.1	-0
34.945	21.60	-.1	-0
34.950	21.60	-.5	-0
34.951	21.59	-.3	1
34.942	21.65	.2	2
34.952	21.59	-.1	3
34.966	21.59	-.7	4
34.972	21.60	.5	5
34.947	21.65	.6	6
34.942	21.65	.7	7
34.944	21.66	1.0	8
34.950	21.66	1.1	9
34.944	21.66	1.0	10
34.958	21.65	1.1	11
34.918	21.65	1.6	12
34.941	21.66	1.8	13
34.944	21.66	1.4	14
34.947	21.64	2.0	15
34.949	21.64	2.2	16
34.960	21.62	2.9	17
34.766	21.61	2.9	18
34.697	21.61	3.1	19
34.931	21.58	3.1	20
34.792	21.58	3.3	21
34.820	21.46	3.3	22
34.849	21.35	3.9	23
34.876	21.27	3.3	24
34.884	21.50	3.7	25
34.867	21.11	4.3	26
34.892	21.04	4.5	27
34.892	21.02	4.5	28
34.898	21.04	4.4	29
34.902	20.73	5.4	30
34.806	20.84	5.8	31
34.910	20.66	5.8	32
34.914	20.77	5.0	33
34.926	20.62	5.7	34
34.928	20.71	6.3	35
34.935	20.66	6.5	36
34.934	20.65	6.0	37
34.950	20.62	6.0	38
34.870	20.60	6.5	39
34.882	20.67	6.5	40
34.904	20.55	6.5	41
34.937	20.52	7.0	42
34.949	20.51	7.1	43
34.943	20.51	7.3	44
34.631	20.49	8.5	45
34.385	20.21	8.1	46
34.514	19.97	7.9	47
34.720	19.68	8.2	48
34.796	19.22	8.6	49
34.745	19.13	8.6	50
34.813	19.05	8.6	51
35.096	18.94	9.6	52
34.768	19.08	9.0	53
34.925	19.08	9.0	54
35.086	19.47	9.6	55
35.359	19.42	9.5	56
35.160	19.89	9.8	57
34.701	19.88	9.0	58
34.659	19.47	10.5	59
34.846	18.92	10.5	60
35.145	18.77	10.3	61
34.715	18.79	10.5	62
34.500	18.58	11.7	63
34.046	18.29	11.3	64
34.581	18.4	11.1	65
34.707	17.99	11.3	66
34.155	17.60	11.7	67
34.245	17.15	11.7	68
34.592	17.07	12.0	69
34.446	17.00	12.6	70
34.523	16.86	13.0	71
34.673	16.86	13.2	72
34.775	16.84	13.7	73
34.820	16.84	13.7	74
34.847	16.80	14.1	75
34.859	16.78	14.1	76
34.880	16.76	14.7	77
34.807	16.75	14.7	78
34.901	16.74	15.1	79
34.901	16.74	15.1	80
34.903	16.71	15.7	81
34.910	15.71	16.2	82
34.914	16.70	15.3	83
34.920	16.70	15.3	84
34.928	16.71	16.0	85
34.944	15.61	16.8	86
34.950	16.71	16.2	87
34.968	16.70	16.2	88
34.972	16.68	16.8	89
34.971	16.68	16.8	90
34.973	16.68	16.6	91
34.976	16.68	16.6	92
34.973	16.68	17.7	93
34.973	16.67	17.3	94
34.969	16.68	17.5	95
34.972	16.66	17.5	96
34.971	16.67	18.7	97
34.971	16.67	18.3	98
34.966	16.66	18.8	99
34.956	16.62	18.8	100
34.948	16.64	19.0	101
34.969	16.64	19.6	102
34.963	16.63	19.6	103
34.967	16.62	20.1	104
34.968	16.43	20.4	105
34.948	16.62	20.6	106
34.976	16.62	21.1	107
34.979	16.62	21.1	108
34.972	16.63	21.3	109
34.973	16.66	21.1	110
34.978	16.61	21.3	111
34.980	16.61	21.3	112
34.980	16.61	21.5	113
34.981	16.60	21.1	114
34.980	16.60	21.1	115
34.979	16.60	21.1	116
34.979	16.60	21.0	117
34.977	16.61	21.5	118
34.973	16.60	22.5	119
34.953	16.58	22.5	120
34.939	16.55	22.8	121
34.944	16.50	22.8	122
34.941	16.46	23.0	123
34.955	16.44	23.0	124
34.951	16.42	24.4	125
34.951	16.40	24.4	126
34.952	16.48	24.9	127
34.951	16.35	24.9	128
34.953	16.33	25.5	129
34.961	16.33	25.5	130
34.966	16.32	26.1	131
34.962	16.31	26.1	132
34.956	16.29	26.5	133
34.961	16.27	26.5	134
34.970	16.27	26.7	135
34.970	16.25	27.0	136
34.972	16.21	26.6	137
34.970	16.19	26.6	138
34.970	16.19	26.6	139
34.960	16.16	26.6	140
34.963	16.14	27.4	141
34.966	16.12	27.2	142
34.970	16.09	27.8	143
34.958	16.09	27.8	144
34.959	16.05	27.8	145
34.962	16.04	28.7	146
34.957	16.04	28.5	147
34.975	16.02	28.5	148
34.980	16.01	29.5	149
34.973	15.99	29.5	150
34.978	15.99	30.1	151
34.983	15.98	30.1	152
34.987	15.98	30.8	153
34.989	15.97	30.8	154
34.991	15.98	31.0	155
34.992	15.98	31.0	156
34.992	15.97	31.2	157
34.992	15.96	31.4	158
34.993	15.97	31.8	159
34.992	15.95	31.8	160
34.994	15.96	31.4	161
34.995	15.96	31.4	162
34.995	15.95	31.4	163
34.995	15.96	31.4	164
34.995	15.95	32.7	165
34.994	15.95	32.7	166
34.994	15.97	32.2	167
34.994	15.96	32.2	168
34.992	15.04	32.3	169
34.994	15.90	32.7	170
34.994	15.96	32.9	171
34.990	15.93	32.9	172
34.992	15.93	33.5	173
34.993	15.94	33.9	174
34.992	15.94	34.1	175
34.993	15.93	34.1	176

4

temperature, and depth as well as the total number of values retained are printed. This printing gives a check that determines whether any unrealistic values were used in the subsequent filtering and averaging routines.

The third subroutine, SMOOTH, performs low-pass filtering to the three channels and decimates. The low-pass filters are a running mean; the numbers for the averages depend on the recording and drop rates. Since our procedures normally produce about five values every meter, a running mean of 5 is applied. Decimation occurs after the second running mean and depth values are rounded to the closest 1-m. interval.

The final subroutine, INTERP (interpret), is an averaging and interpolation package. Values of temperature and salinity that occur in the same 1-m. interval are averaged. Where there are no values in a meter interval, one is linearly interpolated from adjacent values. After this procedure, subroutine SALTFX (salt fix) is called and salinity values are corrected for swift changes in the temperature gradient according to the formula:

$$S = \left(\frac{\partial T}{\partial z}\right) R \tau K S'$$

where S' is the apparent salinity

$\frac{\partial T}{\partial z}$ is the rate of change of temperature with depth

K is a constant ($\sim$ -0.09 p.p.t. per 1°C.)

τ is a thermometer time constant ($\sim$0.35 sec.)

and R is the drop rate.

A final output statement follows this last subroutine.

Figure 3 represents the final output from the data-processing program. Preceding the data are the station number and the total number of observations within the bounds set in TRANS and transmitted to subroutine SMOOTH. Below are the maximum and minimum values of salinity, temperature, and depth used by the smoothing subroutine. Finally, the number of data sets transmitted from SMOOTH to the final subroutine INTERP are given. The data interpolated to a 1-m. interval follow below.

A comparison of the DDL output with the analog output of the STD is presented in figures 4-6. A 600-m. station was chosen for the comparison as it presents most of the features normally encountered on an STD cast. Figure 4 is a reproduction of a cast made near the equator in the eastern Pacific. The surface temperature and salinity noted at the top of the trace were determined from a continuous recording surface TS recorder, periodically checked by bucket temperature and surface-water sample salinity. The numbers adjacent to the profiles represent the salinity scale (4) and the temperature scales (6, ..., 3) used during the cast. The salinity trace is displaced upward (toward a shallower depth), by 5 m. on the depth scale, from the temperature to allow the two pens to cross without interfering with one another. This particular paper does not have the scales printed directly, but they are identical to those at the bottom of figure 5. The spikes in the salinity trace are a feature common to almost all STD casts. They are considered to be a result of a failure of the electronic system in the salinity sensor to respond to sudden changes of the temperature gradient and do not reflect the true salinity at those locations.

Figure 5 is a computer generated plot of the 1-m. values as output from the data processing program. The scales are identical to those of figure 4. The temperature profile is identical to the analog plot reproducing fully temperature inversions and sudden changes in gradient. The salinity trace, when the vertical pen displacement is accounted for, is also reproduced with some spikes totally eliminated and others partially eliminated. The failure to eliminate all the salinity spikes reflects the fact that not all the spike-forming processes are known. The manufacturer has recently noted that there is an intermittency in a portion of the electronic system that responds to a sudden change in temperature gradient as well as a lag response function in the operation of the conductivity to salinity circuitry. The manufacturer

claims to have remedied this circuitry problem in the newer model 9040 STD system. In addition, the numbers used in the salinity correction formula given above are only approximate and may be seriously in error for some instruments and for very different drop rates than assumed here.

It is for these reasons that additional filtering is applied to the salinity trace alone. Figure 6 presents a running mean of 10, applied to the salinities used to produce the profile in figure 5. The type of secondary salinity filtering will ultimately depend on the user's application of the data.

STATION   511

ORIGINAL NO OF OES.   815

MAX.TEMP. 21.66   MIN.TEMP. 13.17   MAX.SAL. 35.359   MIN.SAL. 34.046   MAX.DEPTH 156.8   MIN.DEPTH -.1

NUMBER OF DATA PTS.AFTER SMOOTHING   262

VALUES INTERPOLATED AT 1 METER INTERVALS

DEPTH (M)	TEMP (°C)	SALN (o/oo)	DEPTH (M)	TEMP (°C)	SALN (o/oo)	DEPTH (M)	TEMP (°C)	SALN (o/oo)	DEPTH (M)	TEMP (°C)	SALN (o/oo)
1	21.64	34.955	2	21.64	34.934	3	21.55	34.838	4	21.1/	35.002
5	20.83	34.984	6	20.64	34.926	7	20.53	34.996	8	19.99	34.919
9	19.10	34.954	10	19.26	35.057	11	18.16	34.869	12	17.12	34.632
13	16.86	34.653	14	16.80	34.822	15	16.74	34.9 8	16	16.70	34.945
17	16.68	34.975	18	16.67	34.973	19	16.64	34.965	20	16.63	34.970
21	16.61	34.981	22	16.58	34.989	23	16.48	34.979	24	16.40	34.970
25	16.34	34.965	26	16.30	34.981	27	16.20	35.005	28	16.08	34.994
29	16.02	34.986	30	15.98	34.990	31	15.97	34.994	32	15.96	34.996
33	15.95	34.994	34	15.94	34.994	35	15.94	34.993	36	15.94	34.993
37	15.94	34.993	38	15.94	34.993	39	15.94	34.994	40	15.92	34.992
41	15.91	34.987	42	15.90	34.984	43	15.89	34.977	44	15.8/	34.969
45	15.81	34.986	46	15.71	34.990	47	15.63	34.997	48	15.56	35.000
49	15.52	34.992	50	15.51	34.981	51	15.48	34.993	52	15.44	34.999
53	15.41	34.991	54	15.39	34.986	55	15.36	34.990	56	15.35	34.985
57	15.33	34.980	58	15.31	34.990	59	15.27	34.997	60	15.25	34.994
61	15.24	34.988	62	15.20	34.986	63	15.15	34.988	64	15.06	34.997
65	14.98	34.995	66	14.94	34.989	67	14.90	34.993	68	14.86	34.99/
69	14.83	34.994	70	14.82	34.995	71	14.81	34.998	72	14.81	34.988
73	14.80	34.946	74	14.74	34.963	75	14.40	35.079	76	13.80	35.091
77	13.71	34.983	78	13.69	34.959	79	13.68	34.967	80	13.66	34.9/3
81	13.64	34.973	82	13.64	34.971	83	13.63	34.971	84	13.63	34.971
85	13.62	34.970	86	13.62	34.968	87	13.63	34.969	88	13.63	34.971
89	13.62	34.971	90	13.62	34.970	91	13.61	34.969	92	13.61	34.969
93	13.61	34.968	94	13.60	34.969	95	13.59	34.969	96	13.59	34.968
97	13.59	34.968	98	13.58	34.968	99	13.58	34.967	100	13.58	34.96/
101	13.58	34.968	102	13.57	34.967	103	13.57	34.967	104	13.56	34.967
105	13.56	34.965	106	13.55	34.966	107	13.54	34.965	108	13.54	34.963
109	13.52	34.969	110	13.49	34.969	111	13.48	34.959	112	13.46	34.954
113	13.45	34.957	114	13.43	34.960	115	13.42	34.942	116	13.41	34.959
117	13.40	34.956	118	13.40	34.956	119	13.40	34.957	120	13.40	34.957
121	13.40	34.958	122	13.40	34.957	123	13.40	34.957	124	13.39	34.957
125	13.39	34.954	126	13.39	34.955	127	13.38	34.955	128	13.38	34.956
129	13.37	34.956	130	13.37	34.954	131	13.37	34.954	132	13.37	34.954
133	13.37	34.955	134	13.36	34.954	135	13.37	34.954	136	13.36	34.954
137	13.36	34.953	138	13.36	34.959	139	13.34	34.952	140	13.34	34.920
141	13.32	34.949	142	13.30	34.948	143	13.28	34.948	144	13.26	34.747
145	13.24	34.949	146	13.21	34.950	147	13.19	34.945	148	13.1/	34.942
149	13.19	34.944	150	13.18	34.944	151	13.18	34.943	152	13.18	34.942
153	13.18	34.943	154	13.18	34.943	155	13.18	34.943	156	13.18	34.943
157	13.18	34.945									

Figure 3.—Final output of acceptable values at 1-m. intervals from subroutine INTERP. The station number is printed at the top. Below is the number of observations transmitted to subroutine SMOOTH. The maximum and minimum values transmitted of salinity, temperature, and depth are listed below the numbers of observations. The number of data points after smoothing indicates the number of observations transmitted to subroutine INTERP. (One observation consisted of one value of each of salinity, temperature, and depth.)
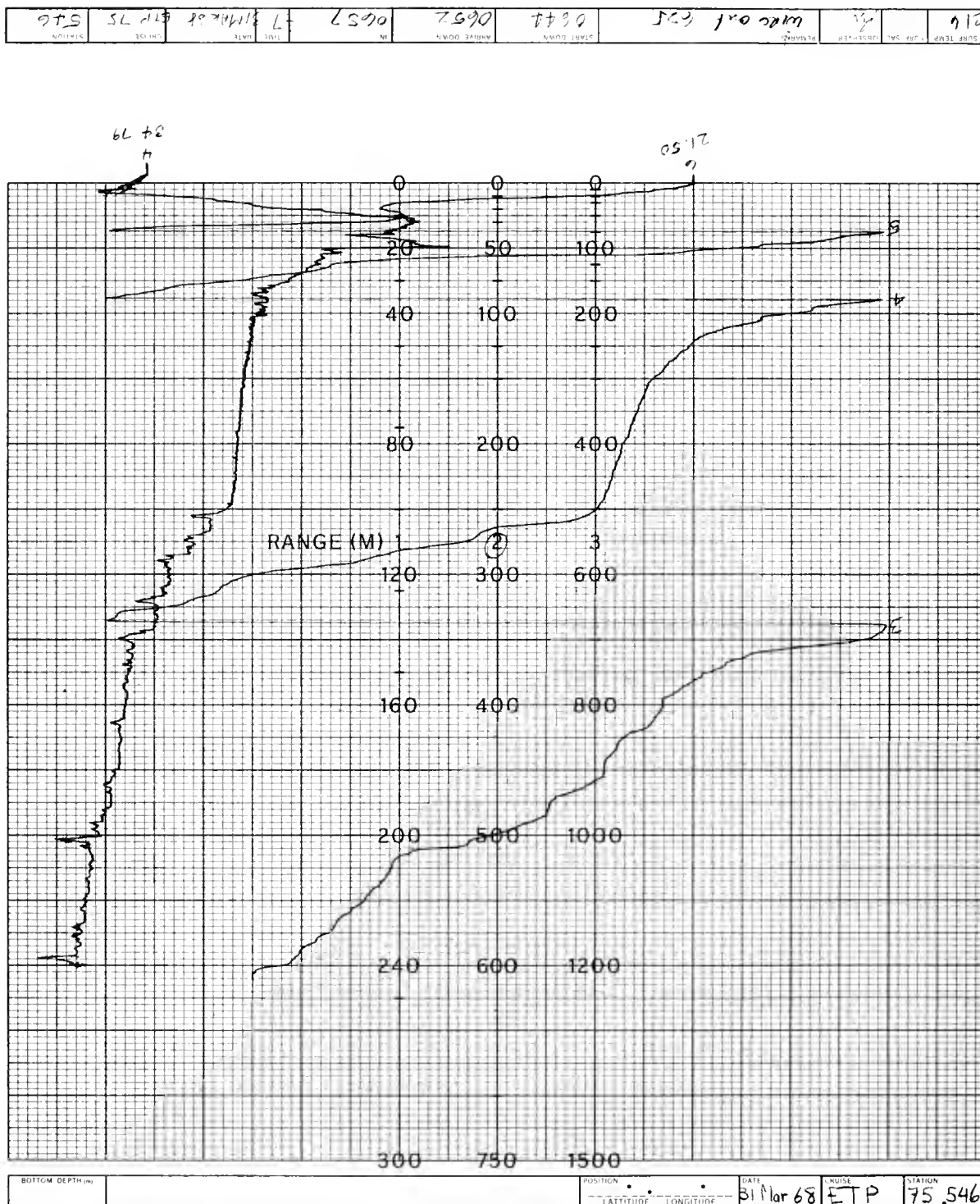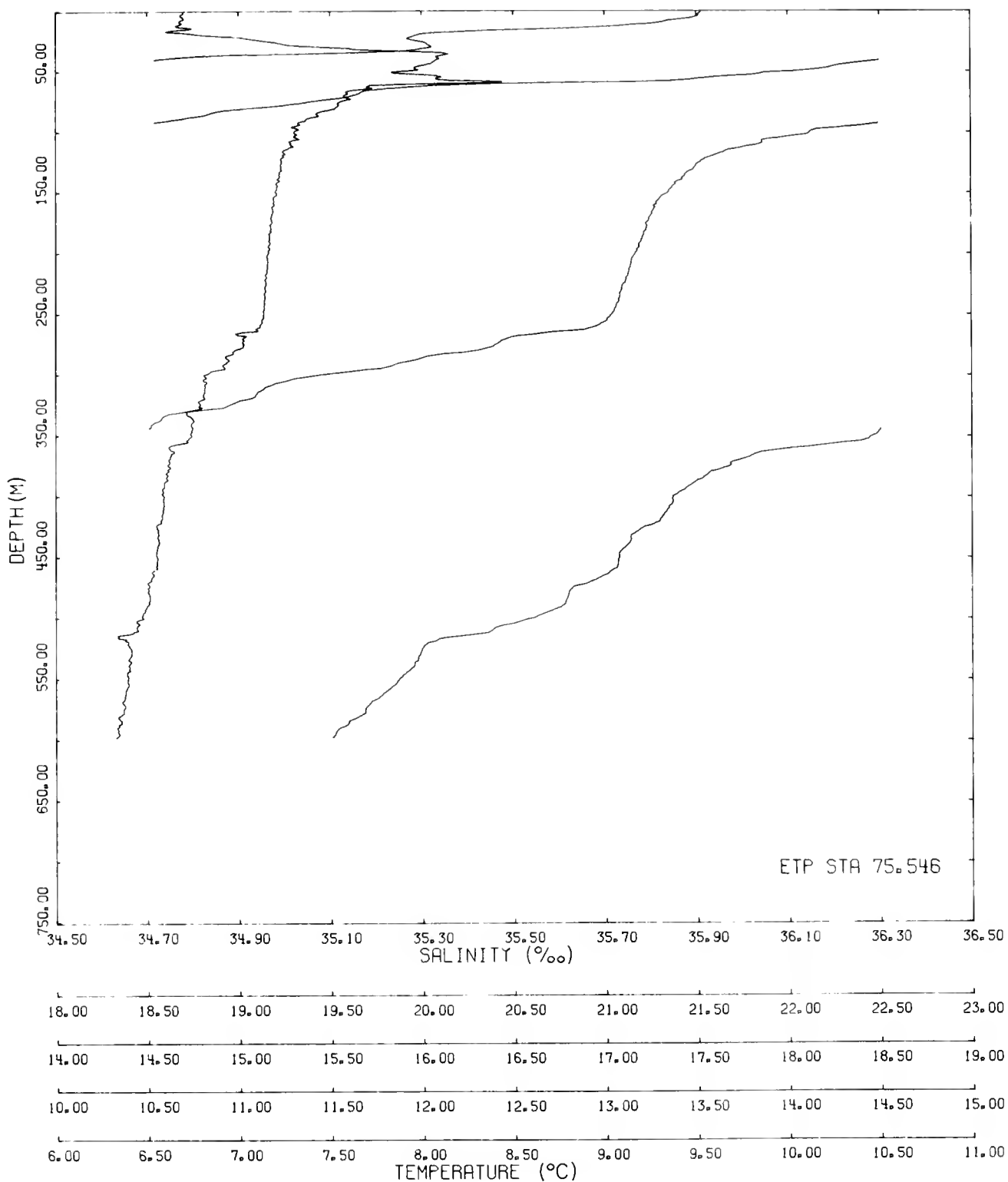
Figure 5.--A plot of the processed digital data logger values as output from the data processing program. Salinity, temperature, and depth scales are identical to those in figure 4.
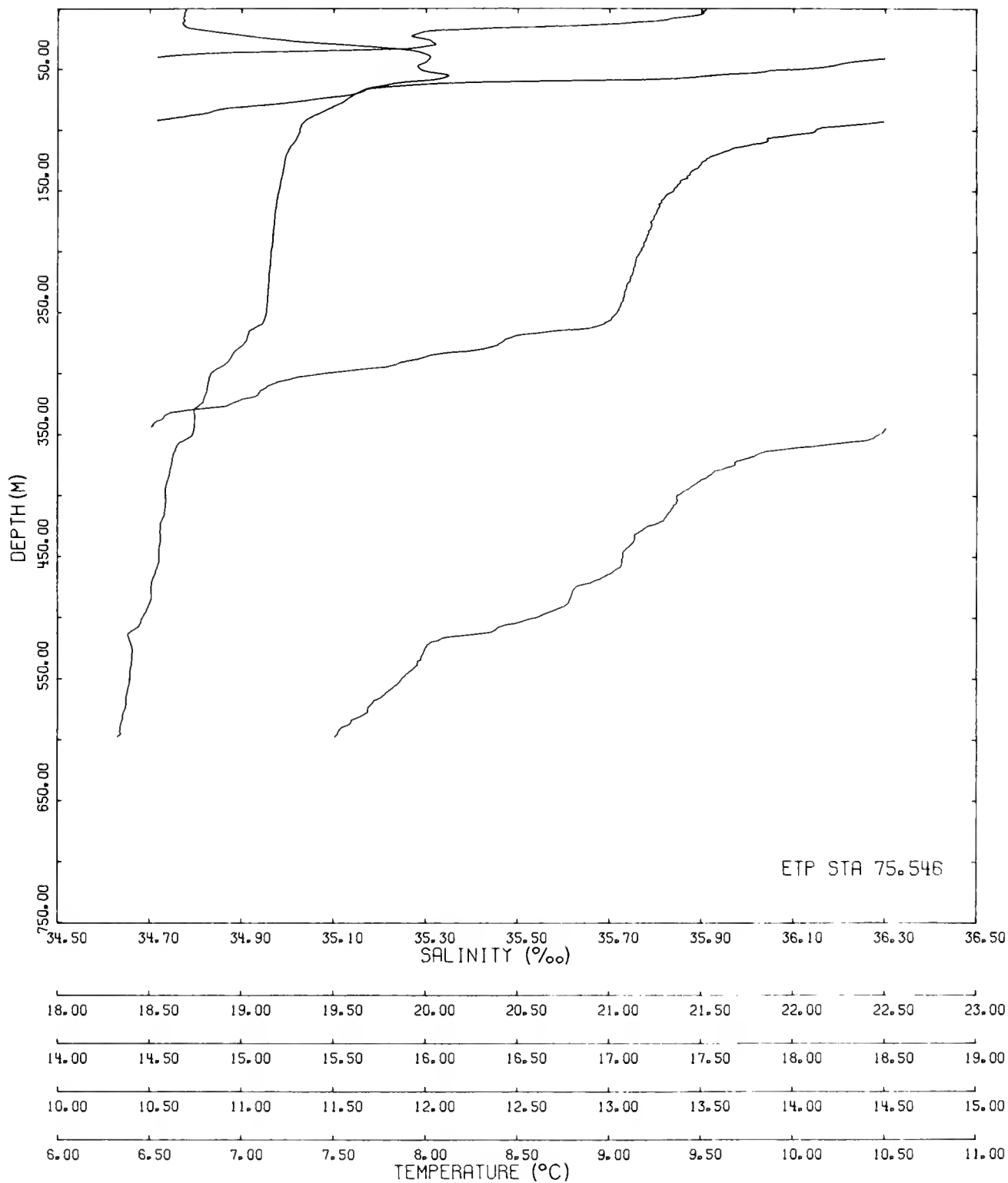
Figure 6.--Plot of processed values with additional filtering applied to the salinity
values. The scales are identical to those in figure 5.

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CONCLUSIONS

The computer program discussed here presents one approach to the data processing of STD digital data logger tapes. There are undoubtedly many alternative techniques which may do just as well. The system described above, however, has the virtue of having been used for nearly 2 years, and it is felt that this program produces a set of data which most nearly represents the signals generated by the STD sensor package, in a form easily interpreted by most of those who need to work with the data.

The additional problems of relating these data with independent measurements and of eliminating random and systemic errors are peculiar to individual instruments, cruises, personnel, and techniques, and almost always must be determined by the experimentor. The method used on the EASTROPAC data was to take the output of the program described here, compare these data with the independent calibrations, and then correct on the computer for any drift or offset noted during the cruise. In addition, the salinity trace is filtered to produce a profile similar to that shown in figure 6.

APPENDIX

A listing of Program RDEDTP and subroutines as used on the University of California, San Diego CDC 3600 computer. Questions concerning individual library subroutines should be directed to the UCSD computer center, La Jolla, Calif. 92037.

```
        PROGRAM RDEDTP                                                    1
C   THIS PROGRAM IS FOR PROCESSING DDL TAPES WITH BIN. LTH. 52, 4 CHANLS
        TYPE INTEGER A,B,C ,FLSTA                                         2
        DIMENSION A(8.),KK(8)                                             3
        DIMENSION NFILE(500),ISTFL(100)                                   4
        COMMON     DD(3300),TT(3300),SS(3300),MO,ISTA                     5
        COMMON     TM,TB,SM,SE,DM,D3,DEPK,SALK,TEMPK                      6
C   THESE CONSTANTS ARE FOR THE SIO DDL AS OF 2/68
        DEPK=95. $ SALK=63. $ TEMP<=7.                                  7 - 9
C   THIS SET OF DATA CARDS ARE FOR SIO NO. 2 FISH
        DFMIN=9712. $ DFMAX=11288. $ DMIN=0. $ DMAX=1500.               10 - 13
        TFMIN=2127. $ TFMAX=4193. $ TMIN=-2. $ TMAX=35.                 14 - 17
        SFMIN=4995. $ SFMAX=7901. $ SMIN=30. $ SMAX=40.                 18 - 21
        TM=(TMAX-TMIN)/(TFMAX-TFMIN)                                     22
        TB=(TMIN*TFMAX-TFMIN*TMAX)/(TFMAX-TFMIN)                         23
        DM=(DMAX-DMIN)/(DFMAX-DFMIN)                                     24
        DB=(DMIN*DFMAX-DFMTN*DMAX)/(DFMAX-DFMIN)                         25
        SM=(SMAX-SMIN)/(SFMAX-SFMIN)                                     26
        SB=(SMIN*SFMAX-SFMIN*SMAX)/(SFMAX-SFMIN)                         27
C   NUMFIL IS THE NUMBER OF FILES TO BE TRANSLATED
C   NFILE(I) ARE THE FILES TO BE PROCESSED
C   NOSTA2 IS THE NUMBER OF OF FILES WITH NO HEADING INFO
C   ISTFL(I) ARE THE FILES THAT NEED STATION NUMBERS
C   ILL IS THE FIRST FILE TO BE PROCESSED
C   IFLMAX IS THE LAST FILE TO BE PROCESSED
        READ 22,NUMFIL $ READ 21, (NFILE(I),I=1,NUMFIL)                 28    29
        READ 22, NOSTA2 $ READ 21,(ISTFL(I),I=1,NOSTA2)                30    31
21      FORMAT (1615)                                                   32
22      FORMAT (I5)                                                     33
        IFLMAX=116                                                      34
        NS=1 $ ILL=1                                                    35    36
60      NF=NFILE(ILL) $ CALL TAPEPOS (11,NF,0) $ ILL=ILL+1             37 - 39
        BUFFER IN (11,1) (A(1),A(52))                                   40
100     IF (UNIT,11) 100,400,60,200                                     41
200     LL=LENGTHF(11) $ GO TO 401                                     42    43
400     LL=LENGTHF(11) $ IF (LL.EQ.52) 399,401                         44    45
399     PRINT 58                                                        46
58      FORMAT (1H0,32H NO STATION NUMBER FOR THIS CAST )              47
        ISTA=ISTFL(NS) $ NS=NS+1 $ PRINT 421,ISTA $ BACKSPACE 11       48 - 51
        GO TO 501                                                       52
401     LK = 8*LL $ DO 406 IEI=1,L-    $ KABC=A(IBI)                   53 - 55
406     DECODE (8,410,KABC) KK                                         56
410     FORMAT ( 8R1)                                                   57
        ISTA=100*KK(1)+10*KK(2)+KK(3) $ PRINT 421,ISTA                 58    59
421     FORMAT (14H0 STATION    ,I5)                                   60
501     NF=NFILE(ILL) $ CALL TAPEPOS (11,NF,0) $ ILL=ILL+1            61 - 63
        CALL TRANS                                                      64
        IFILE=LUFILE (11) $ IF (IFI_E.GE.IFLMAX) 900,890              65    66
890     GO TO 60                                                        67
900     CONTINUE                                                        68
        END                                                            69
```

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```
       SUBROUTINE TRANS                                                    1
       TYPE INTEGER A,B,C                                                  2
       DIMENSION A(8.),B(500),KK(8),D(32),T(32),S(32),NO(32),DX(32)        3
       COMMON    DD(3300),TT(3300),SS(3300),MO,ISTA                        4
       COMMON    TM,TB,SM,SE,DM,DB,DEPK,SALK,TEMPK                         5
       KR=1 $ J2=0 $ JE=0                                                6 - 8
499    BUFFER IN (11,1) (A(1),A(80))                                       9
500    IF (UNIT.11) 500,550,800,550                                      10
800    IF (JE) 52,499                                                    11
550    LL=LENGTHF(11)                                                  12
       LK=8*LL  $ JE=1 $ IA=1                                         13 - 15
       DO 600 IY=1,LL $ KABC=A(IY) $ DECODE (8.410,KABC) KK         16 - 18
410    FORMAT (8R1)                                                     19
       DO 601 IX=1,8$ B(IA) = KK(IX)                                 20,21
601    IA =IA +1                                                        22
600    I=0   $  DO 49, IV=1,LK,13                                    23,24
       DY = B(IV)*1024 + R(IV+1)*32 + B(IV+2)                          25
       SY = B(IV+3)*1024 + E(IV+4)*32 + B(IV+5)                        26
       TY = B(IV+6)*1024 + E(IV+7)*32 + B(IV+8)                        27
       SV = B(IV+9)*1024 + E(IV+10)*32 + R(IV+11)                      28
       I=I+1                                                           29
       D(I) =(DM*DEPK*5.E6)/(DY*32768.)+DB                             30
       S(I) =(SM*SALK*5.E6)/(SY*32768.)+SB                             31
       T(I) = (TM*TEMPK*5.E6)/TY+TB                                    32
       IF (D(I).GT.1110.,OR.D(I).-.T.,-.2)491,612                    33,35
612    J2=J2+1 $ NO(I)=J2                                            36 - 39
       DD(J2)=D(I) $ TT(J2)=T(I) $ SS(J2)=S(I) $ DX(I)=D(I)           40
       GO TO 490                                                       41,42
491    NO(I)=0 $ DX(I)=DD(J2)                                          43
490    CONTINUE                                                        44
C      PRINT 431,(D(I),T(I),S(I),NO(I),I=1,32) $ PRINT 432            45
431    FORMAT (4(X,F6.1,F7.2,F8,3,15,3X))                             46
432    FORMAT (1H0)                                                    47
       IF (J2.GT.3265) 50,51                                          48
50     GO TO 52                                                        49
51     CALL BASKET (DX,J2,KR)                                         50
       GO TO 499                                                      51,52
52     MO=J2-1                                                        53,54
       DMAX=ARRAYMAX(DD,MO) $ DMIN=ARRAYMIN(DD,MO)                    55,56
       TMAX=ARRAYMAX (TT,MO) $ TMIN=ARRAYMIN (TT,MO)                  57,58
       SMAX=ARRAYMAX (SS,MO) $ SMIN=ARRAYMIN (SS,MO)                   59
       PRINT 56,MO $ PRINT 57,TMAX,TMIN,SMAX,SMIN,DMAX,DMIN            60
56     FORMAT (1H0,20H ORIGINAL NO OF OBS., 15)                       61
57     FORMAT (1H0,1,H MAX.TEMP.,F6.2,2X,10H MIN.TEMP.,F6.2,2X,1 H MAX.SA  62
      1L. ,F7.3,2X,10H MIN.SAL. ,F7.3,2X,10H MAX.DEPTH,F6.1,2X,1 H MIN.DE
      2PTH,F6.1)
       CALL SMOOTH
       END
```

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```
      SUBROUTINE BASKET (D,J2,KR)                             1
      DIMENSION D(2),DR(300)                                  2
      DR(KR)=(D(1)+D(2)+D(3)+D(4)+D(5))/5.                    3
      IF (KR.LF.5) 72,70                                      4
70    IF (IBAD) 74,73                                         5
73    DKP=DR(KR-1)                                            6

      IBAD=1                                                  7
74    IF(DR(KR).LT.DKP) 69,72                                 8
69    IF (J2.LT.33) 75,71                                     9
71    J2=J2-32                                               10
      GO TO 75                                               11
72    IBAD=0                                                 12
75    CONTINUE                                               13
      KR=KR+1                                                14
      END                                                    15
```

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```
      SUBROUTINE SMOOTH                                                    1
      DIMENSION X(3300),Z(3300),ID(3000)                                  2
      COMMON D(330),T(3300),S(3300),M,ISTA                                3
      K=1                                                                 4
    4 IF (K-2) 20,21,22                                                   5
   20 DO 5 I=1,M                                                          6
    5 Z(I)=T(I) $ GO TO 30                                            7   8
   21 DO 6 I=1,M                                                          9
    6 Z(I)=S(I) $ GO TO 30                                           10  11
   22 DO 7 I=1,M                                                         12
    7 Z(I)=D(I) $ GO TO 30                                           13  14
   30 X(1)=Z(1) $ X(2)=(Z(1)+Z(2))/2. $ M2=M-2                       15 - 17
   10 X(I)=        (Z(I-2)+Z(I-1)+Z(I)+Z(I+1)+Z(I+2))/5.                 18
      X(M)=Z(M) $ X(M-1)=(Z(M-1)+Z(M))/2.                            19
      IF(K-2)40,41,42                                               20  21
   40 DO 12 I=1,M                                                        22
   12 T(I)=X(I) $ GO TO 60                                          23  24
   41 DO 13 I=1,M                                                        25
   13 S(I)=X(I) $ GO TO 60                                          26  27
   42 DO 14 I=1,M                                                        28
   14 D(I)=X(I) $ GO TO 61                                          29  30
   60 K=K+1$ GO TO 4                                                31  32
   61 CONTINUE                                                          33
C                                                                       34
      PRINT 3,(D(I),T(I),S(I),I,I=1,M)                                  35
    3 FORMAT (4(X,F6.1,F7.2,F8.3,I5,3X))                           36  37  38
      DO 7 J=3,M,3                                                      37
      D(J)=(D(J-1)+D(J)+D(J+1))/3, $ T(J)=(T(J-1)+T(J)+T(J+1))/3,   39  40
      S(J)=(S(J-1)+S(J)+S(J+1))/3, $ J=1                            41 - 45
   70 DO 100 I=3,M,3 $ D(I)=D(I) $ T(I)=T(I) $ S(I)=S(I)  $ J=J+1   46  47
  100 JJ=J-1 $ JJP=JJ                                                   48
      DO 300 J=1,JJP                                                49  51
  300 TD(I)=D(I)+.5 $ L=0 $ K=1                                     52  53
      DO 200 I=2,JJP $ IF(ID(I).GE.ID(K))22G,ID(K))220,200         54  58
  220 L=L+1 $ TD(L)=ID(I) $ T(L)=T(I) $ S(L)=S(I) $ K=I                 59
  200 CONTINUE                                                          60
      PRINT 450,L                                                       61
  450 FORMAT (1H0,36H NUMBER OF DATA PTS.AFTER SMOOTHING ,I5)           62
      CALL INTERP (L,ID,T,S,ISTA)                                       63
      END
```

21

```
      SUBROUTINE INTERP (MC,D,T,S,ISTA)                                    1
      DIMENSION D(2),T(2),S(2),DD(1112),TT(1112),SS(1112)                  2
      TYPE INTEGER D,DD                                                    3
      K=0 $ D(2)=D(1)                                                    4 - 5
      DO 100 I=1,MO                                                         6
      M=1 $ IF(D(I+M).EQ.D(I)) 10,14                                     7 - 8
   10 M=M+1                                                                 9
      IF(D(I+M).EQ.D(I)) 10,15                                            10
   15 SUMT=0 $ SUMS=0 $K=K+1 $ XM=FLOATF(M)                            11 - 14
      DO 30 N=1,M $ SUMT=SUMT+T(I-1+N)                                    15
      SUMS=SUMS+S(I-1+N)                                                  16
   30 DD(K)=D(I) $ TT(K)=SUMT/XM $ SS(K)=SUMS/XM $ I=I+M-2               17
      GO TO 100                                                        18 - 21
   14 INK=D(I+1)-D(I) $ FINK=FLOATF(INK)                                 22
      DO 50 J=1,INK                                                      23
      K=K+1 $ FJ=FLOATF(J) $ DD(K)=DD(K-1)+1                            24
      TT(K)=T(I)+(T(I+1)-T(I))*(FJ/FINK)                               25 - 28
   50 SS(K)=S(I)+(S(I+1)-S(I))*(FJ/FINK)                                 29
      IF (DD(K).EQ.D(I+2)) 51,100                                        30
   51 K=K-1                                                              31
  100 CONTINUE                                                           32
      CALL SALTFX (K,SS,TT)                                              33
      PRINT 20 $ PRINT 440 $ PRINT 441                                   34
   20 FORMAT (1H0, 48H  VALUES INTERPOLATED AT 1 METER INTERVALS  )    35 - 37
  440 FORMAT(1H0,116HDEPTH  TEMP  SALN    DEPTH  TEMP  SALN    DEPTH  TEMP  SALN )   38
  441 FORMAT(1H0,115H  (M)  (OC)  (O/00)    (M)  (OC)  (O/OO)    (M)  (OC)  (O/OO) )   39
    1 PRINT 1,(DD(I),TT(I),SS(I),I=1,K)                                  40
    1 FORMAT (4(X, I6 ,F7.2,F8.3,8X))                                    41
      PRINT 11                                                           42
   11 FORMAT (1H1)                                                       43
C     WRITE (10) ISTA,K $ WRITE(10)(DD(I),TT(I),SS(I),I=1,K)$ ENDFILE 10  44
      END                                                                45
```

23

```
      SUBROUTINE SALTFX (MC,S,T)                                          1
      DIMENSION S(2),T(2)                                                 2
      M4=M0-4                                                             3
      DO 130 I=4,M4                                                       4
      S(I)=S(I)*(1.-0.0212*1.118*0.35*((T(I+1)+T(I-1))/T(I))*             5
     C(-T(I+3)+9.*(T(I+1)-T(I-1)+T(I-3))/24.)                            6
  130 CONTINUE
      END                                                                7
```

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